Set off *Om* equal to the outside lap and draw $CC_2$ through *m* perpendicular to AA'. Then C is the main-crank position at admission and $C_2$ of the cut-off. Likewise set off *Ot* on the opposite side from *Om* equal to the inside lap, then $v_l$ is the release point and % the compression point.

The lead is the amount the valve is open when the main crank is at dead-centre, i.e. at X-L *considering the cover-side of the cylinder.* The valve displacement when the crank is at $X_x$ is *Om'.* The valve lap is *Om,* therefore the opening is *Qm'* less *Om,* i.e. *m'm,* i.e. the radius of the *lead circle at* $X_x$.

If the given data is the point of cut-off, the valve travel, and the lead, then the known dimensions are:

*(a)* the radius of the valve circle, i.e. OC;
(6) the radius of the lead circle at $X_x$, i.e. /;
*(c)* the position of $C_2$.

The construction is then: draw a circle of radius equal to half of the valve travel and rule perpendicular lines XX' and YY'. With $X_x$ as centre draw a circle of radius /. Draw a tangent through $C_2$ to this circle intersecting the valve circle at C. Draw AA' through O perpendicular to $CC_2$ and bi-secting it. The angle A'OY is the angle of *advance 9, Om* the *outside lap.*

To find the inside lap the point of release or compression would have to be prescribed.

Obliquity of Connecting-rod.—If the connecting-rod were infinitely long, the piston-displacement could be found, corresponding to the events—admission, cut-off, release, compression—by dropping perpendiculars from C, $C_2$, *v*± and % (fig. 15 *a)* on to $XX_X$. Thus *Od* is the displacement of the piston from its mean position at cut-off when the connecting-rod is very long relative to the main-crank throw.

If the connecting-rod is not very long a length is taken on a pair of compasses representing the length of the connecting-rod on the same scale as the radius of the valve circle represents the main-crank throw. Taking a centre on $XX_X$ produced, strike an arc through any representative point, say $C_2$. The intersection of the arc with $XX_X$ marks $d^f$—the actual point of admission, so that *Od'* is now the true piston displacement allowing for the obliquity of the connecting-rod.

Zeuner's Diagram.—A very simple modification can be made by means of Zeuner's circles. Suppose CQ (fig. *i6c)* is the valve circle and C a representative point on the circle, the angle AOC being the " phase " of the eccentric at C, i.e. 0. With centre on AA' and radius | OA' draw the small circle shown. OD is the displacement of the valve from its mean position. But OD = OD', for the triangles ODC and OD'A' have equal angles and a side OA' and OC equal. Hence if a radial line is drawn to C from O the intersect OD' made by the small circle measures the valve displacement.

Obviously another circle can be added, shown dotted in fig. i6c, to give the displacements radial lines such as OC", and if these Zeuner circles are added together on the line AA' of fig. 16 *a,* fig. 16 *b* is obtained.